

A Nuclear Ramjet Flyer for Exploration of Jovian Atmosphere

by

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Galileo Probe

To date, only direct measurement of Jovian atmospheric properties.

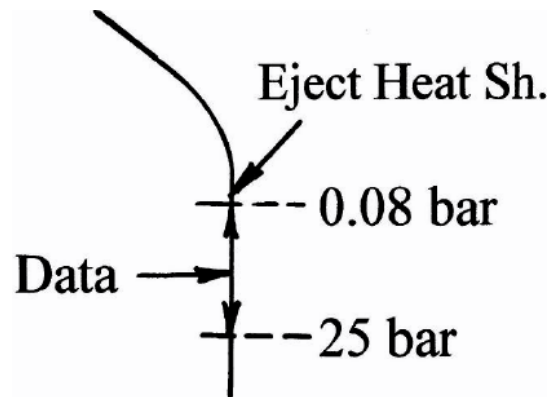
Launched: 1989

Entered Jovian Atmosphere: December 7, 1995

$v = 47.4 \text{ km/s}$

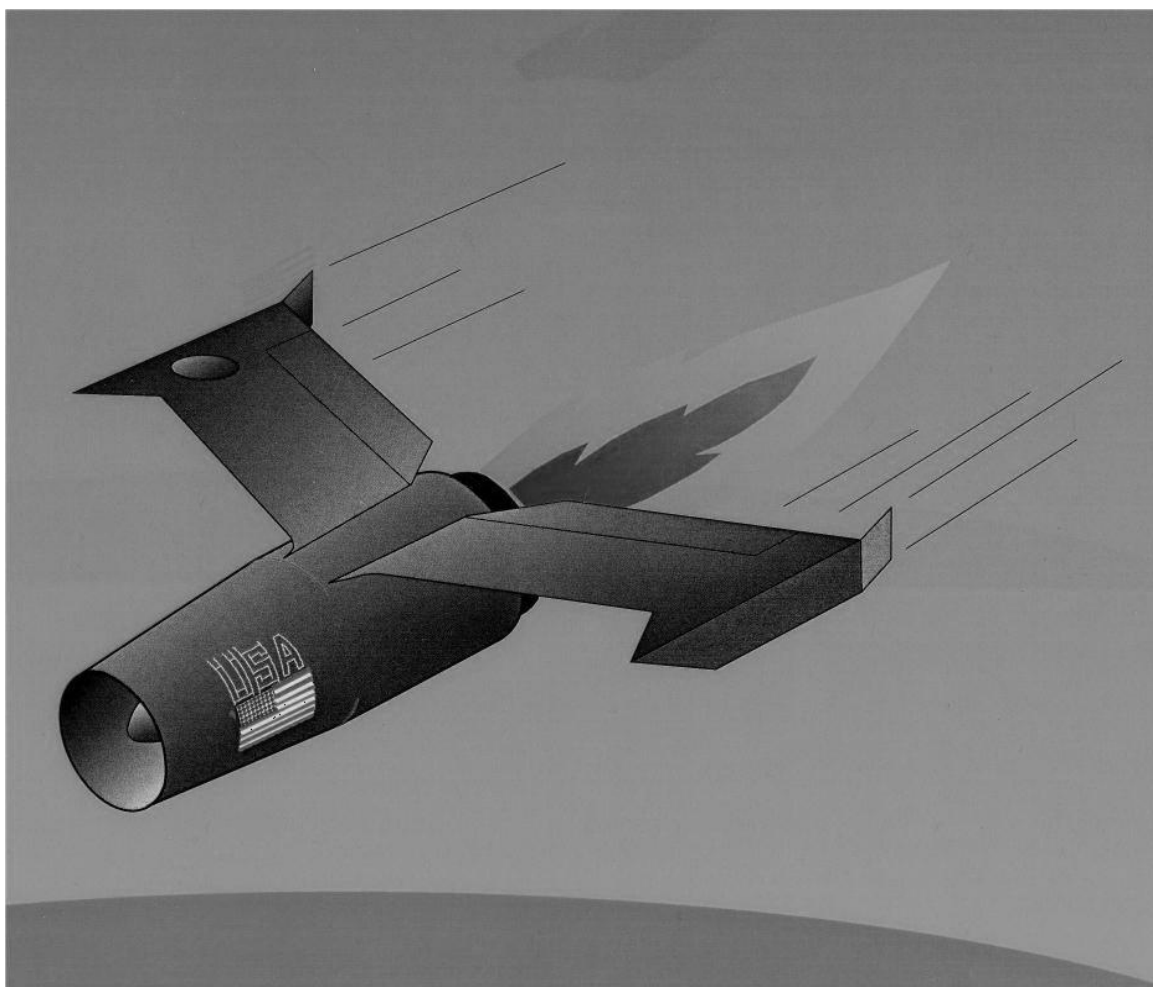
$T_o = 15,000^\circ\text{C}$

Decel. = 230g



Characteristics of Nuclear Ramjet Flyer:

- Jovian atmosphere is an unlimited source of propellant.
- MITEE compact nuclear reactor is (nearly) unlimited source of heat.
- With few moving parts mechanical wear should be minimal.



MITEE Nuclear Engine

- MITEE (**M**iniature Reac**T**or **E**ngine)
Ref.: *Acta Astronautica*, Vol. 44, No.2-4,
1999
 - Derivative of Ultra-Light Particle Bed
Reactor (PBR) Developed for SDIO (1985 -
1993)
 - MITEE is lighter and more compact than
PBR.
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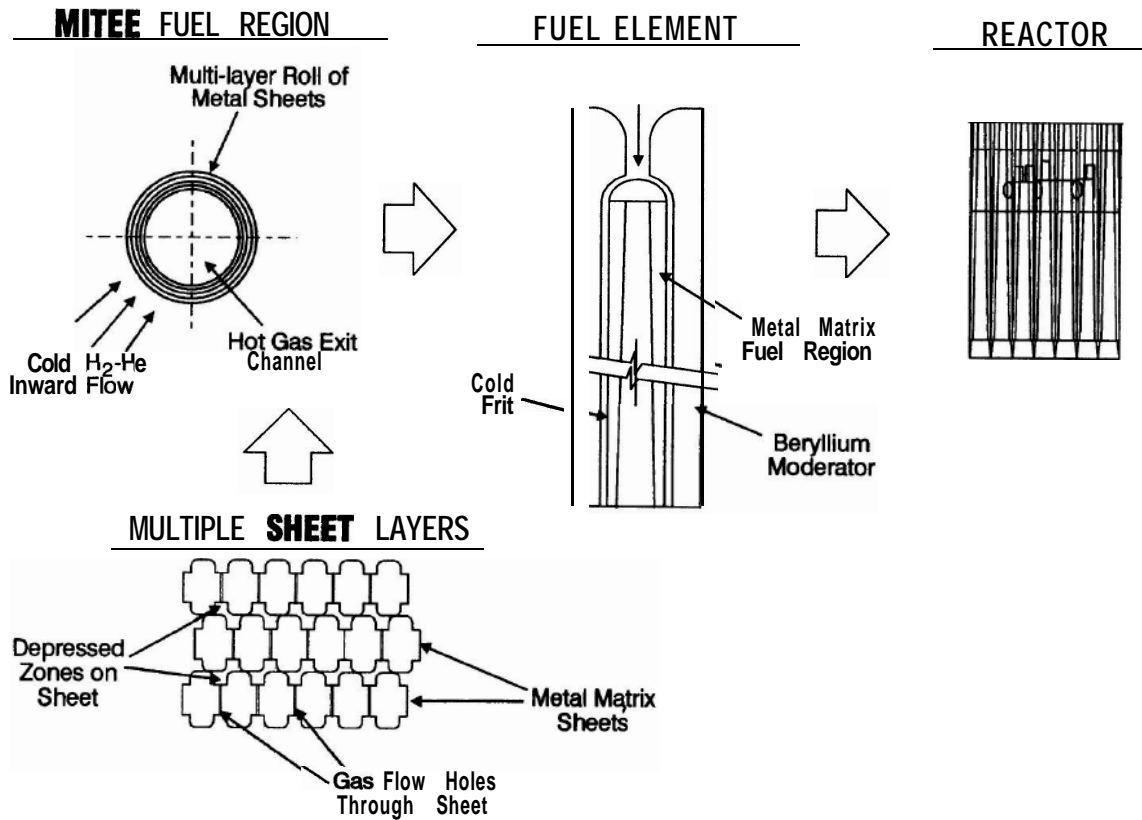
MITEE Nuclear Engine (Contd.)

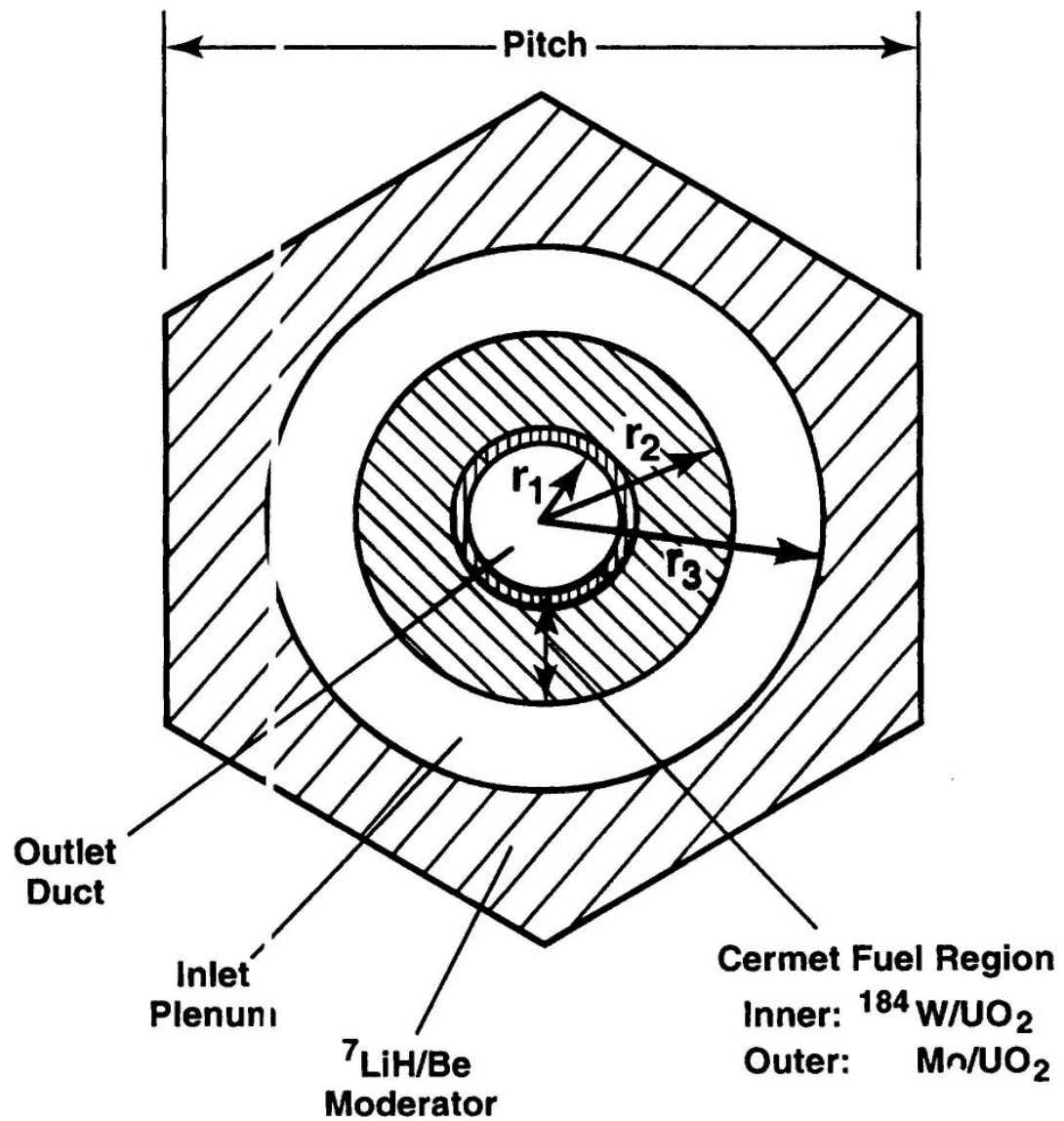
- Have Proposed MITEE-Based Rocket Engine for Solar System Exploration Missions:
 - Jupiter Orbiter: 2 Years
 - Europa Lander/Sample Return: 5 Years
 - Pluto Fly-By: 7 Years
 - Gravitational Lens at 550 AU: 30 Years

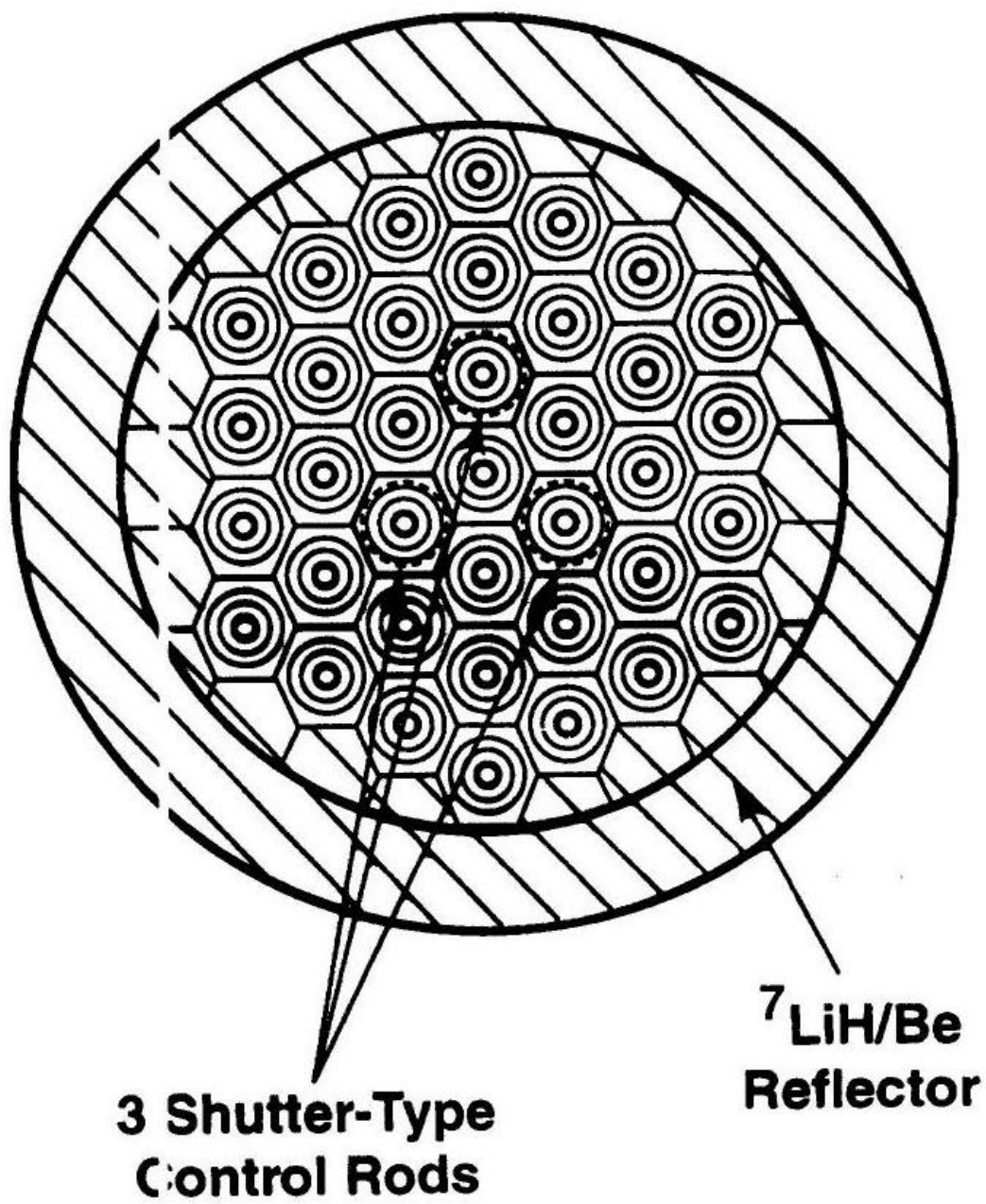
MITEE Nuclear Engine (Contd.)

- MITEE can be adapted for **ramjet** application:
 - Replace H_2 propellant supply system by inlet and diffuser.
 - Reduce power density from 10 MW/liter to 2 Mw/liter
 - Reduce outlet temperature from 3000 K to 1500 K
 - Increase operating life from -1 hr to months.

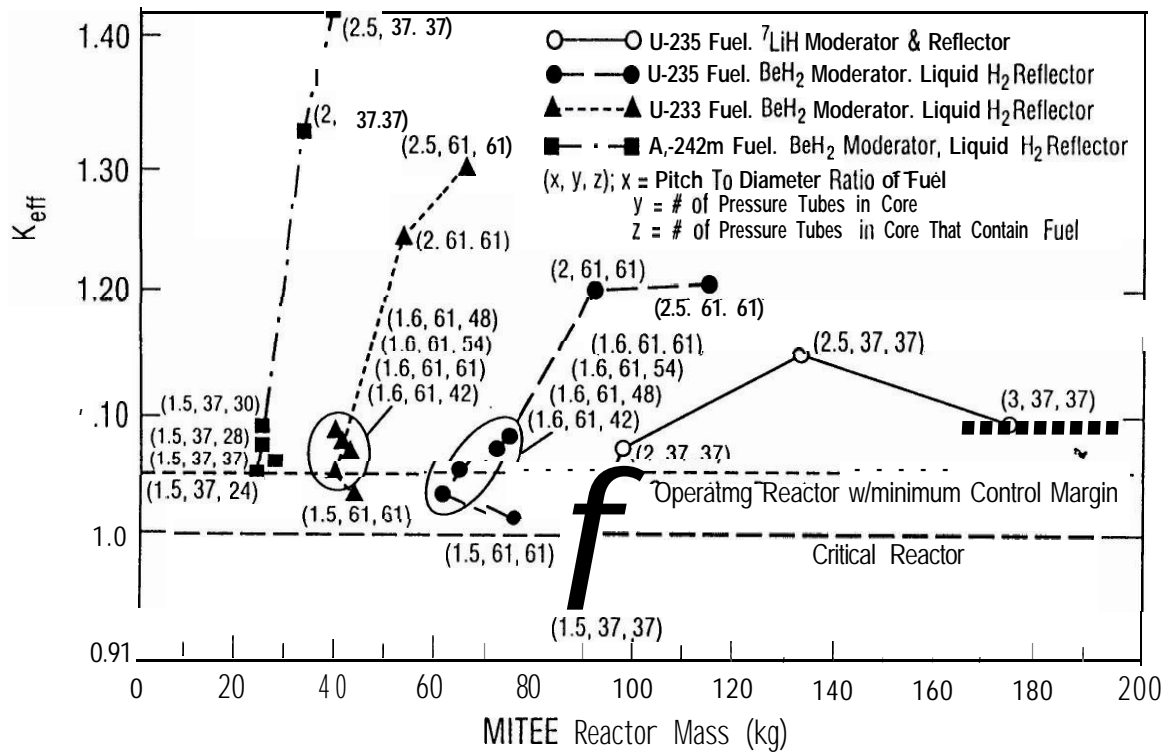
THE MIT-ACTOR **ASSEMBLY**





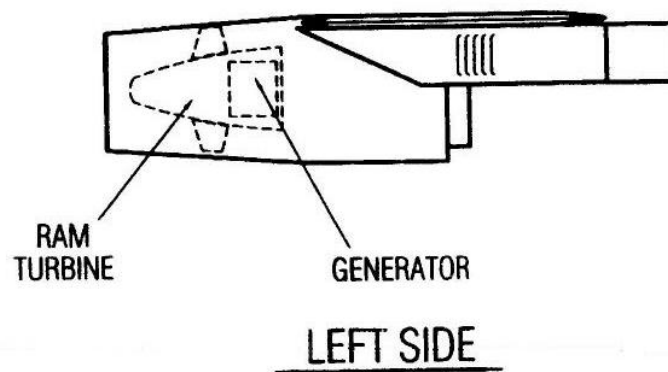
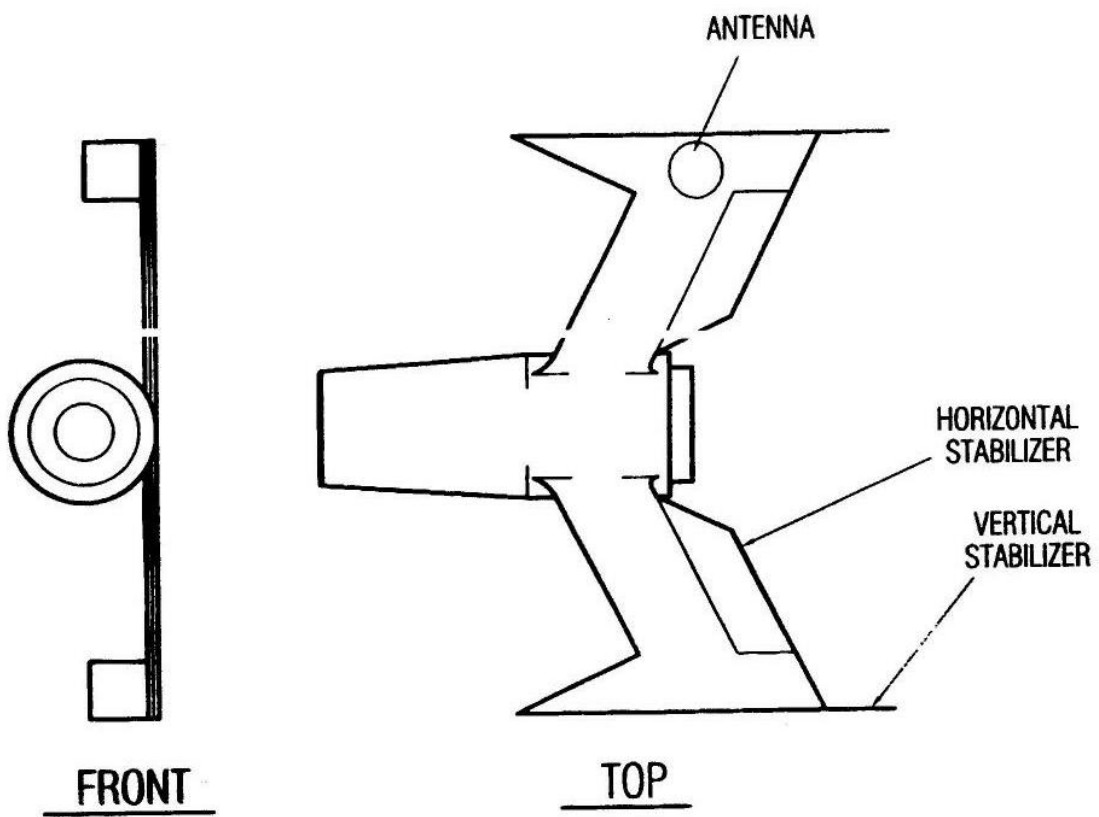


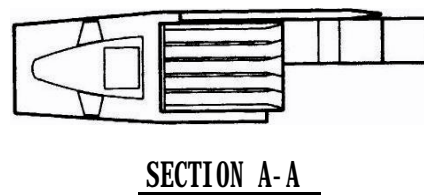
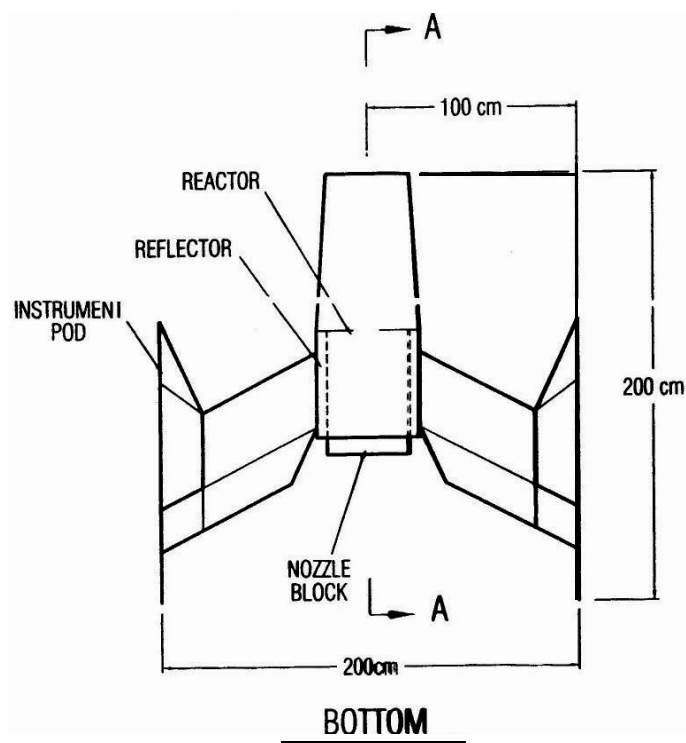
Criticality Constant (K_{eff}) vs MITEE Reactor Mass For Different Fissile Fuels and Core Configurations

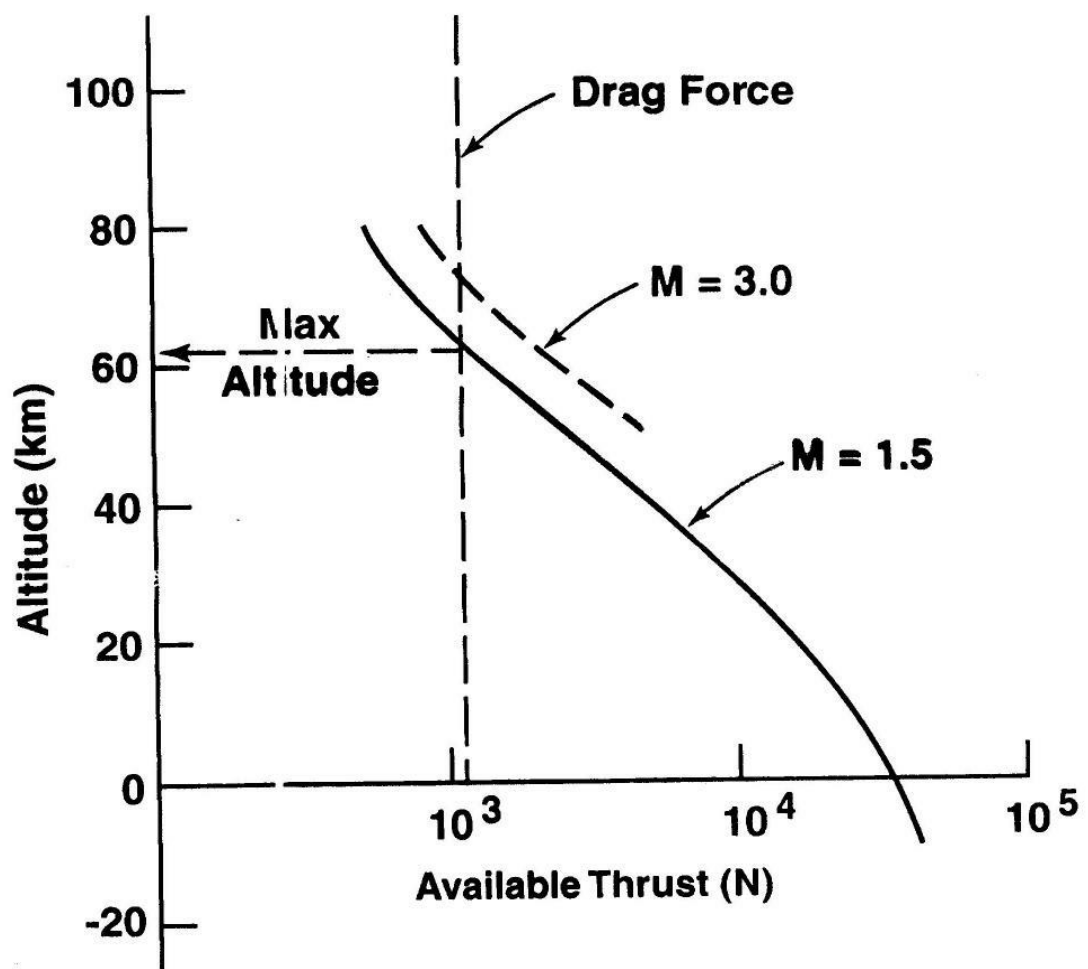


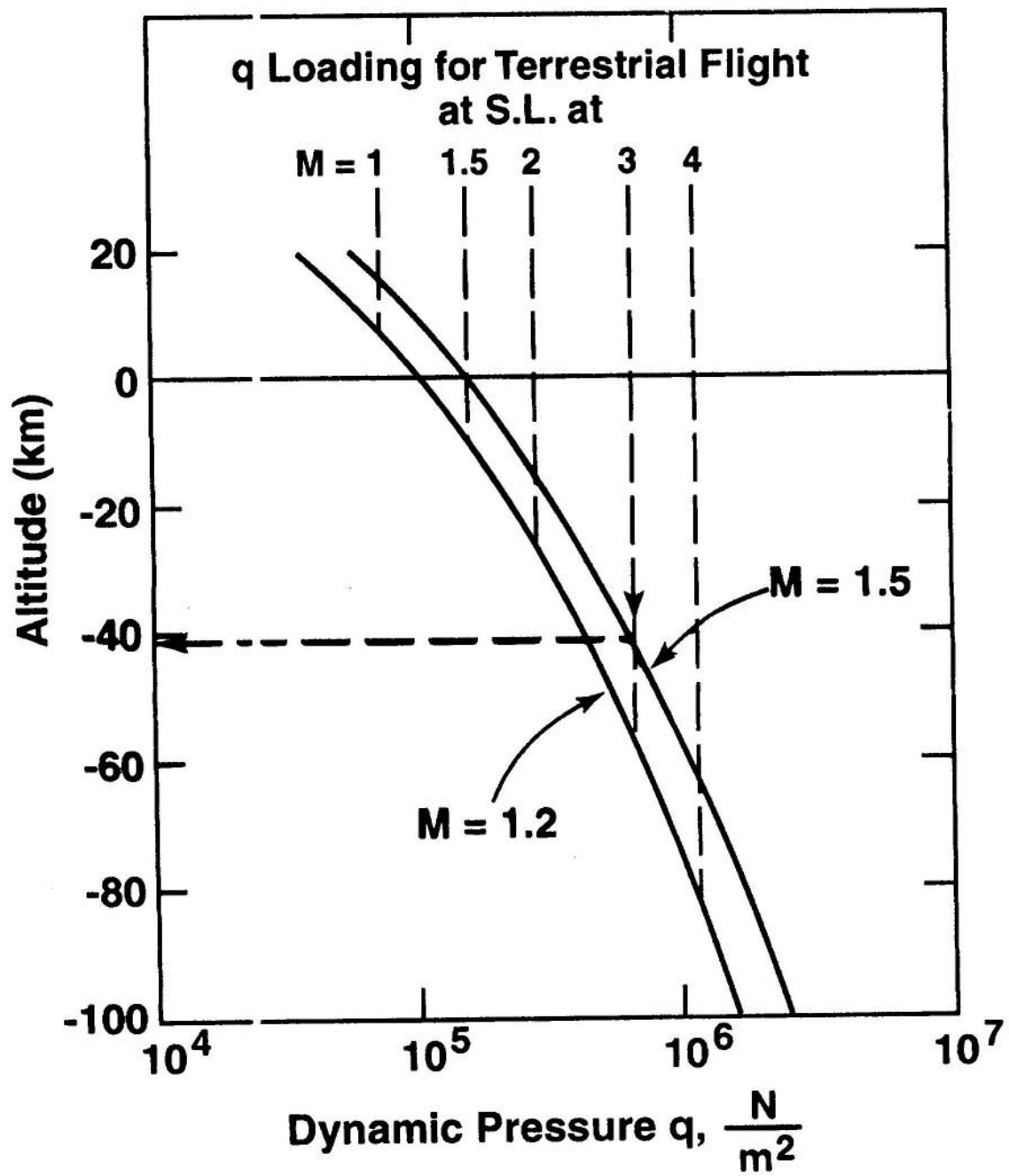
Radiation Safety

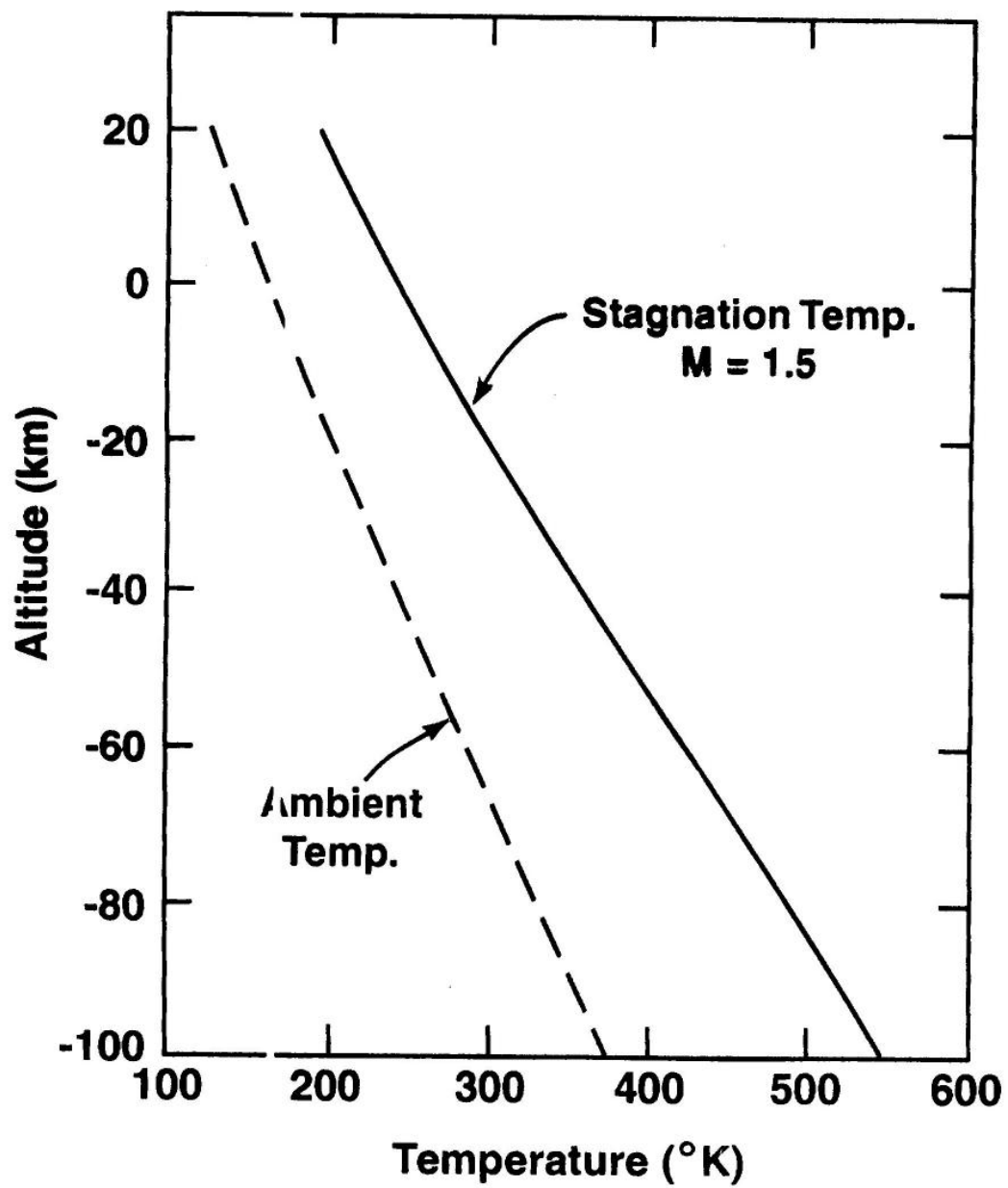
- Before reactor startup nuclear fuel is not hazardous.
- Reactor will start operation after Jovian entry.
- During launch phase (from Earth) safety systems prevent criticality for all conceivable accidents.



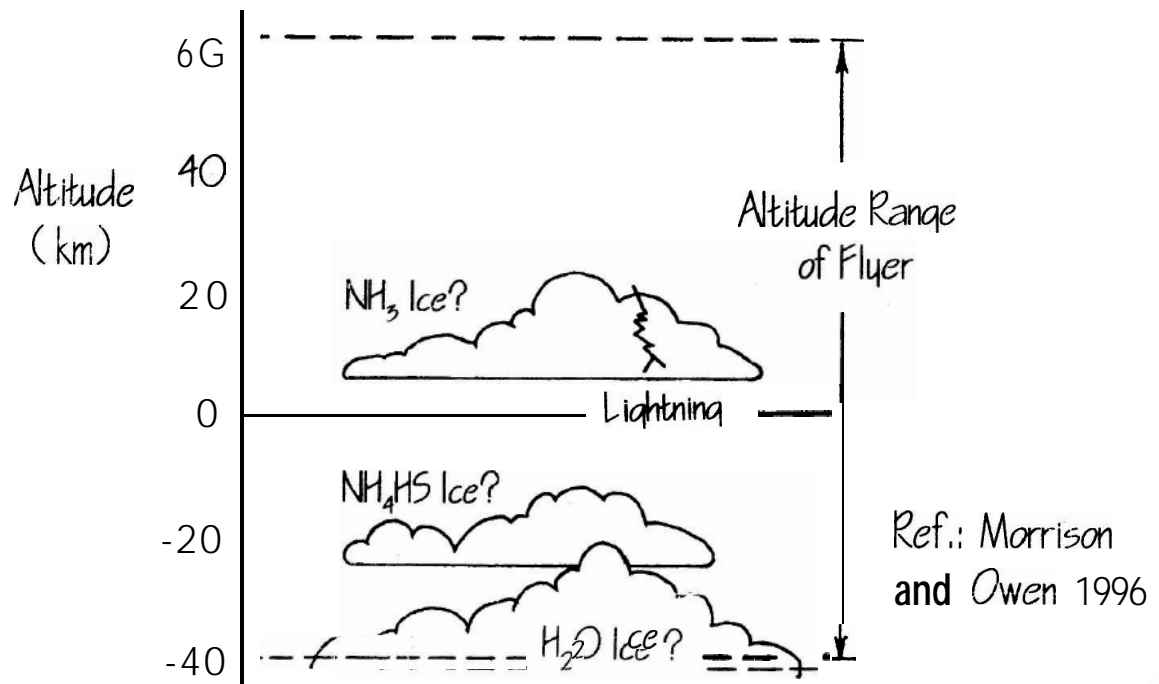








Ramjet Flight Envelope

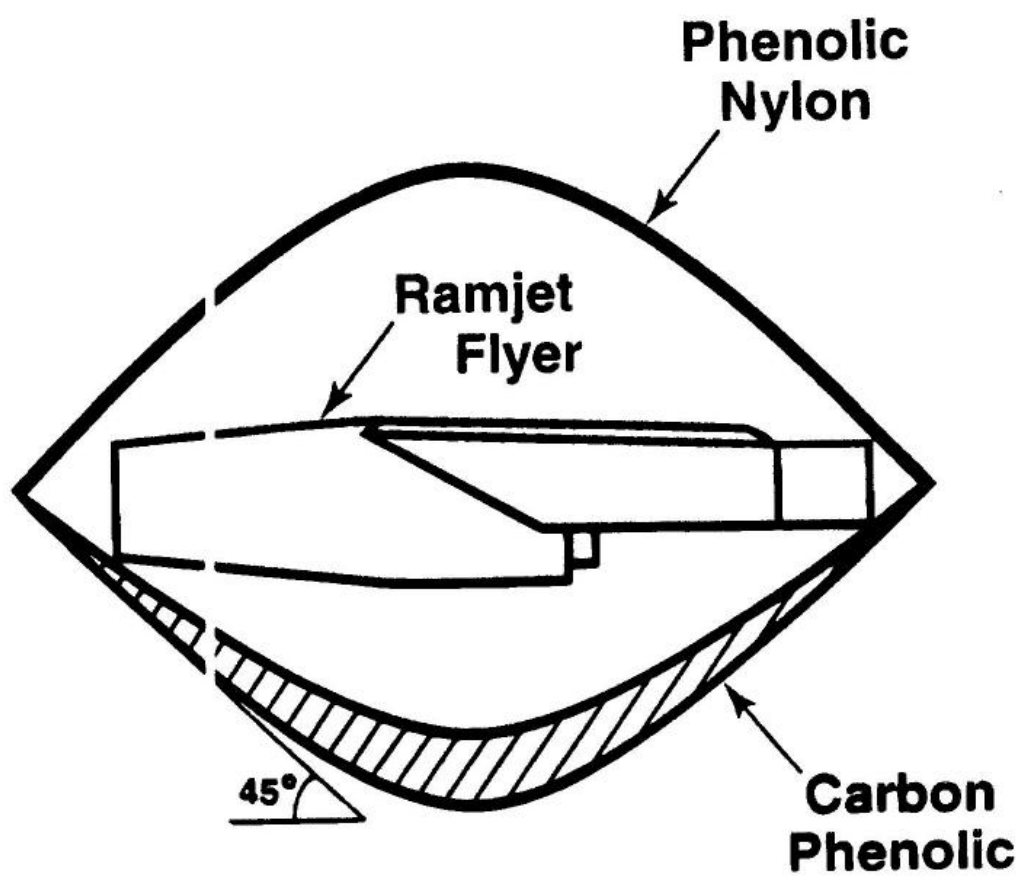


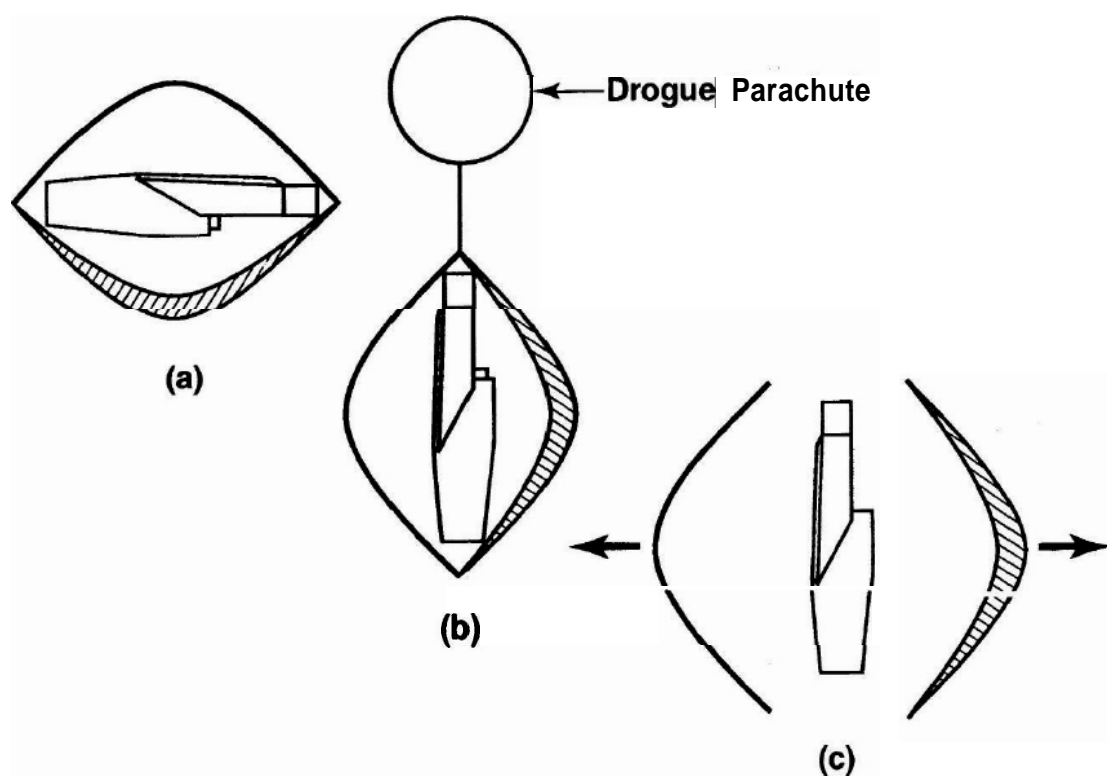
Mission Characteristics

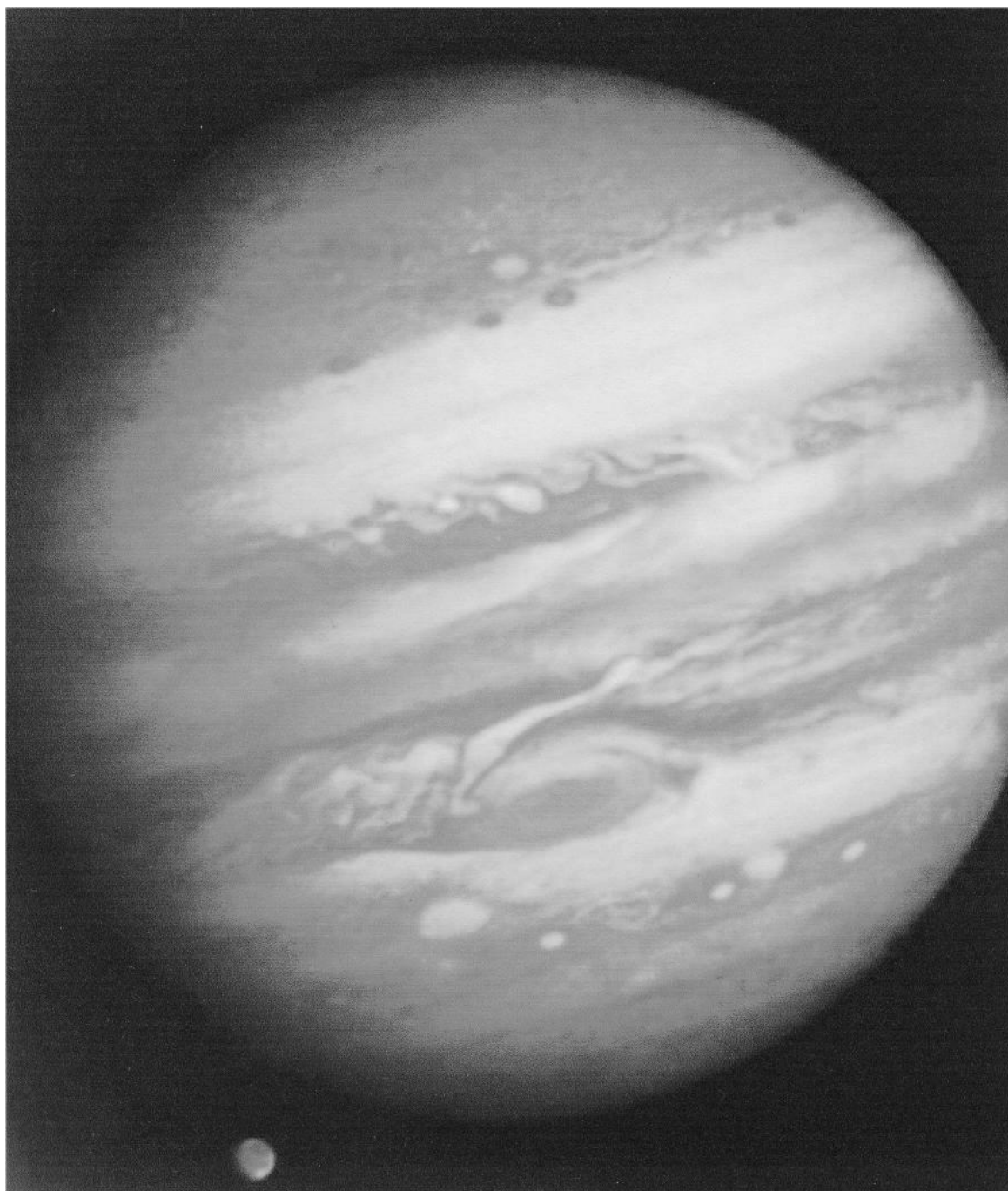
- Payload of 640 kg, comprised of
 - Ramjet Flyer 220 kg
 - Thermal Shield 220 kg
 - Companion Orbiter 200 kg
- Launch into LEO w. chemical rocket (Atlas IIAS).
- From LEO, fly to Jupiter using:
 - Chemical rocket with GA's: ~ 6 years
 - MITEE Nuclear rocket (if available): 2 years

Mission Characteristics (Contd.)

- Deployment of Companion Satellite.
Jovian entry profile similar to Galileo.
- When entry package has slowed to Mach ~ 1.5 , flyer separates from thermal shield.
Nuclear engine starts.
- Flyer commences atmospheric mapping operation.







Atmospheric Properties Measured

- Pressure
- Temperature
- Chemical Composition
- Wind Velocity
- Cloud Particles and Size Distribution
- Lightning Frequency and Energy
- Energy Flux From Sunlight
- Energy Flux from Deep Interior

Conclusions

- Ramjet flyer provides unique tool for mapping in detail Jovian atmosphere.
- Detailed data should help explain poorly understood features of Jovian atmosphere, e.g., the Great Red Spot.
- Concept applicable to other planetary atmospheres.